ENGINEERING RESEARCH INSTITUTE

UNIVERSITY OF MICHIGAN

PROPOSAL FOR A REMOTELY OPERATED HOT CELL AND PROCESSING BUILDING

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I. INTRODUCTION

One of the major problems associated with industrial utilization of nuclear engineering is the problems of processing fuels and radiochemicals into useable form. Work done at the University of Michigan, Atomic Energy Commission sites, and at other locations has demonstrated that many uses can be made of nuclear radiations. Some of this work indicates promise to the point that the complexion of fission product wastes changes from a high cost waste disposal problem to a product that can have considerable value. For industrial use of fission products as radiation sources to become widespread, the cost of these fission products in convenient package form must be kept low.

The intent of this proposal is to provide at the University remote operating and handling facilities which can be integrated with the activities of the University's nuclear reactor now under construction.

The proposed facility will offer extended opportunities in University research and teaching in the unknowns of nuclear energy, thus creating new knowledge.

Means are provided so that investigations can result in cheap processes for separating reactor fuels from fission products, methods of packaging fission products can be examined, and application of the radiation from fission products at mega-curie levels for a wide variety of new purposes can be studied. By these means, the University through its programs can assume the leadership in providing an ever expanding useful technology and training.

The building provides chemical laboratory facilities and hot sampling stations, adequate office space for the building staff and all associated building facilities. Total cost for the building and installed equipment is approximately $600,000.

II. ADVANTAGES FACILITY WOULD GIVE THE UNIVERSITY OF MICHIGAN

Primary interest the University has in such a facility is the training and teaching of personnel in the techniques of remotely operated processes, handling of mega-curie levels of activity, and in the application of these materials and techniques for further research. The facility proposed is designed for training of students in small groups as laboratory courses as well as graduate research.

Many possibilities exist for research utilizing radiation from fission products. Considerable work has already been done at the University of Michigan, Fission Products Laboratory, in this field. The proposed facility would permit work to be done at much higher radiation flux levels than heretofore. As an example, radiation promoted chemical reactions would react much faster in the

higher flux permitting more economical use of research time. Reactions may be discovered that were undetected at lower radiation flux levels. New products and new processes in many phases of our life can result. In addition, such operations as sterilization, polymerization, and irradiation of polymers could be conducted in a much shorter period of time at the radiation flux levels proposed than for currently available flux levels.

A processing cell and necessary equipment provides the means of investigating processes for separating fission products from fissionable material and to educate personnel in the techniques of design and operation of such processes. Space can be made available for research into processes for separating specific fission products from gross fission products and in packaging these products into convenient, safe, and economical containers.

Chemical laboratory space and equipment is provided for analytical control work. This space is also available for training and research on tracer techniques or other problems requiring the use of small quantities of radioactive material, thus implementing the Phoenix Memorial Building. Hoods, laboratory benches, glove boxes, and chemical storage facilities have been provided.

Space is available in the directly operated areas for pilot plant work on a small scale. This space was provided primarily to be integrated with the irradiation facilities in the hot cell for the study of irradiation initiated chemical reactions. However, this space can be used for other purposes.

Offices and building facilities are provided for use by the building occupants. One large office could be converted to classroom use.

The facility proposed would be the first of its kind outside of the Atomic Energy Commission.

Facilities for research in the discussed fields are not commonly available to industry and possession of such facilities by the University would aid materially in getting high caliber graduate students. Many research projects, both sponsored and academic, would be forthcoming for the same reasons.

III. BUILDING DESCRIPTION AND OPERATION

A. Building Design

The tentative building design uses a slightly sloping roof of simple beam type construction. Roof is insulated sheet metal with an upper reflecting surface. Walls are block construction with a sprayed paint exterior and interior. Window sills and door frames are metal with the window panes in aluminum frames. Floors of the offices, corridors, laboratories, and lavatories, are concrete base with an asphalt tile covering. Floors in the cold makeup and operating areas, utilities room, and sampling corridors, are painted concrete. Partition walls are of block construction, paint sprayed. A loading ramp is provided at the rear of the building. An exterior view of this building is shown in Figure 1.

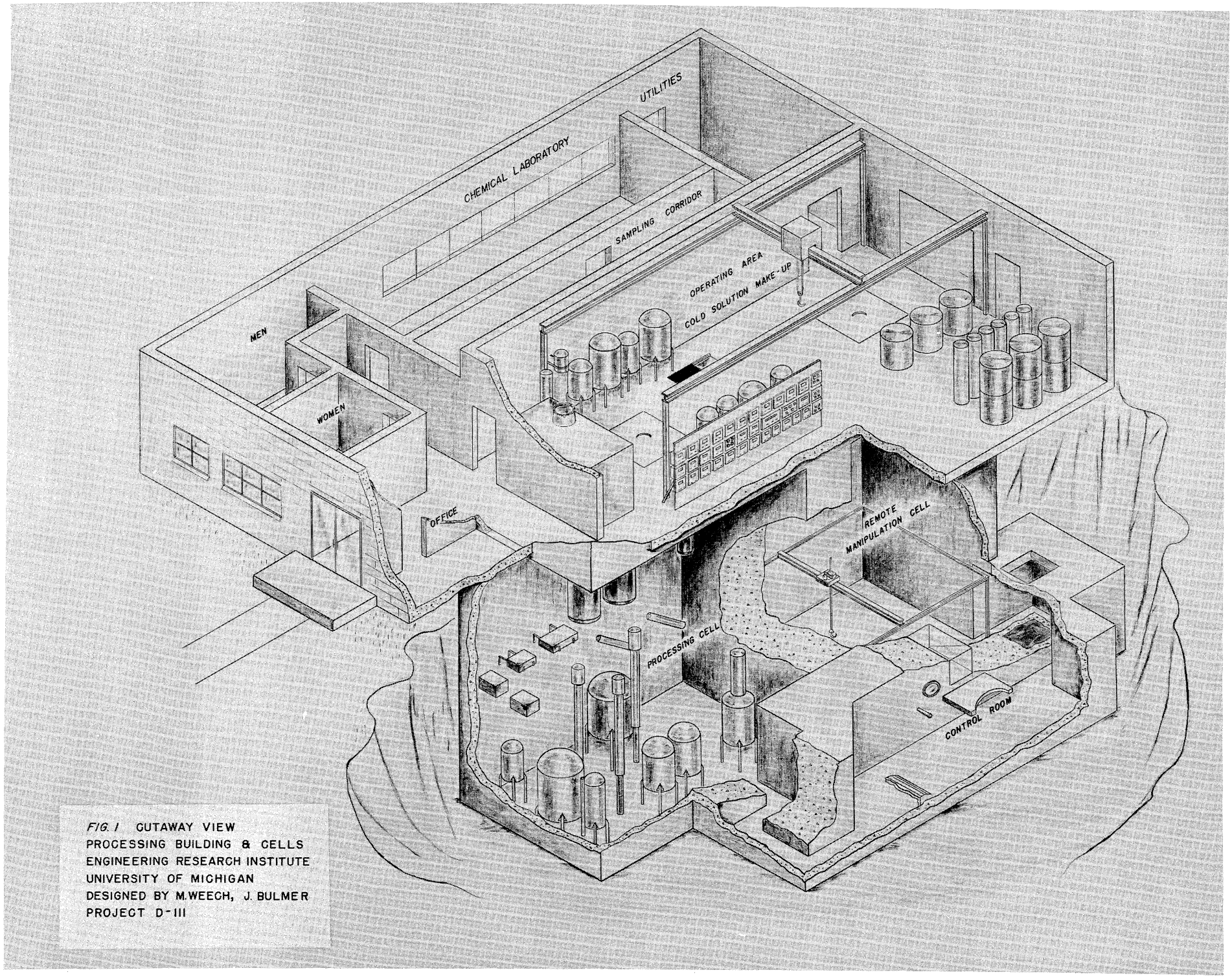

FIG. 1 CUTAWAY VIEW
PROCESSING BUILDING & CELLS
ENGINEERING RESEARCH INSTITUTE
UNIVERSITY OF MICHIGAN
DESIGNED BY M.WEECH, J. BULMER
PROJECT D-111

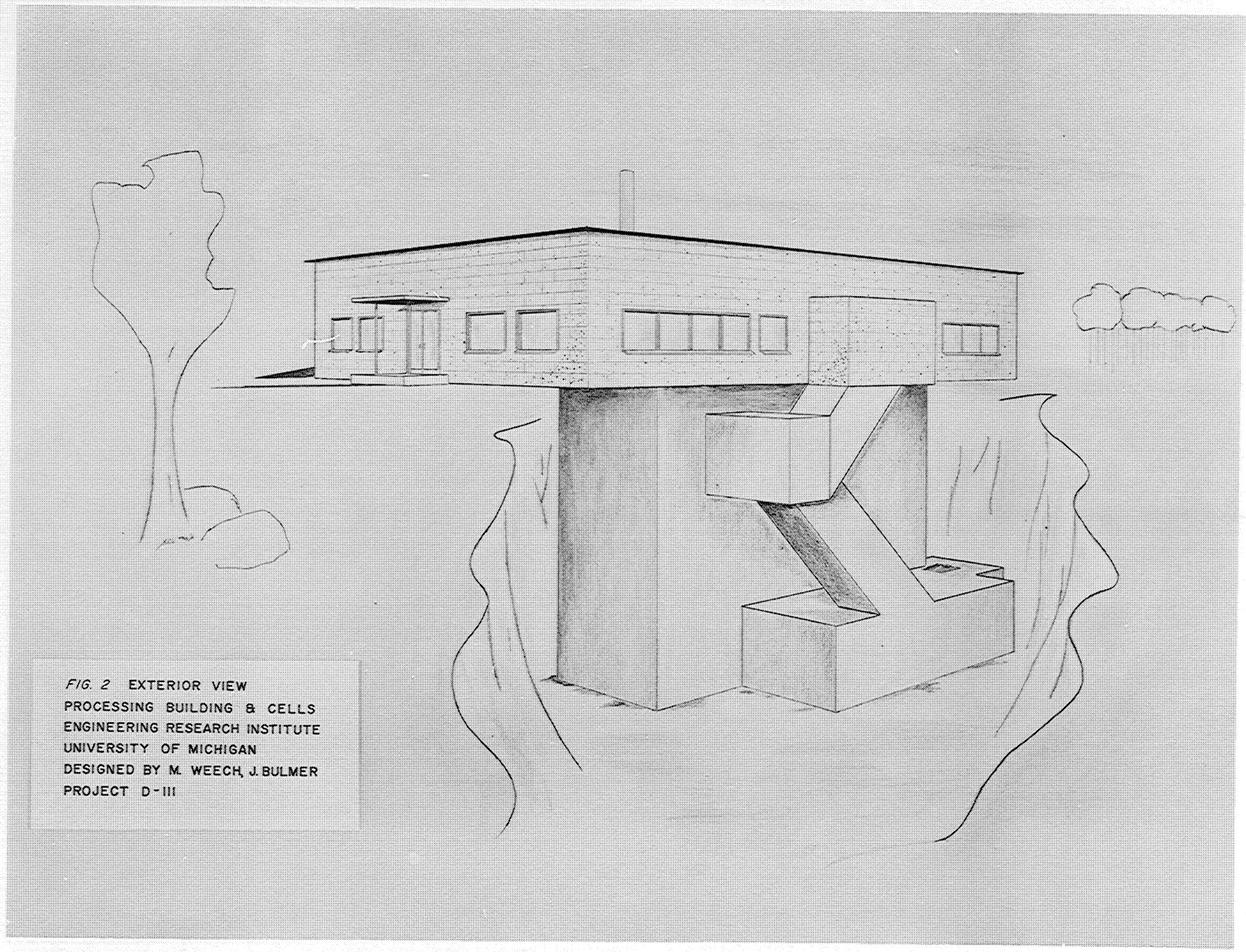

FIG. 2 EXTERIOR VIEW
PROCESSING BUILDING & CELLS
ENGINEERING RESEARCH INSTITUTE
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DESIGNED BY M. WEECH, J. BULMER
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B. Cell and Building Arrangement

The position of the cells in relation to the building is shown in Figure 1 with the cell access stairway shown in Figure 2. The cells are arranged so that a minimum of 5-1/2 feet of concrete is always between any personnel working in the area and any radiation source in the cell. Maximum advantage of earth shielding is taken whenever possible. The precautions taken will assure a lower than tolerance radiation level for all personnel in normal work locations.

1. Processing Cell

In this cell is housed the equipment to make a separation of fission products from fissionable material. It is assumed that the starting material will be irradiated fuel elements of an MTR type that could come from the University reactor or other sources. These elements are charged to a dissolver and dissolved in nitric acid with the resultant solution, then routed through the process equipment. The products from the processes are essentially two aqueous streams; one containing the uranium solution which is cold from a radiation standpoint, with the other stream containing the highly radioactive fission products. The cold uranium is returned to the Atomic Energy Commission and the fission products are retained in the cell for investigation of processing and packaging techniques. This process of separating uranium from fission products is a proven type that is currently used at many Atomic Energy installations.

The equipment layout in the processing cell is shown in the engineering drawings D-111-91-2 and D-111-91-3.

Instruments for controlling the process are placed on the control board in the Cold Service and Operating Area as shown in D-111-91-1. Also in this area are the cold makeup and feed tanks that are used to feed streams to the process. Access to the processing cell can be had through a covered hatchway in the top of the cell. This cover can be removed with the overhead bridge crane shown in D-111-91-1.

As in any research of chemical processes, there are a number of waste streams which must be disposed. In this process there are gaseous and liquid wastes that must be discarded. Each of these streams can be decontaminated before discharging to the atmosphere or sewer. The liquid waste streams are evaporated and condensed several times, then analyzed for radioactivity before discharging. At the time of discharge, drinking water specifications can be met. Gaseous wastes are handled by neutralization and scrubbing with caustic and adsorbing all radioactive fission product gases in an adsorption bed, and then filtering before discharge up a stack. The gases being discharged are monitored continually before discharge. The off-gas system is shown in D-111-92-3. Adsorption beds are placed in a shielded area as shown in D-111-91-1, items 425-1 and 425-2.

A second personnel access to the processing cell is provided by the stairway shown if Figure 2, D-111-91-1, 2, and 4.

Engineering flowsheets of the equipment in the processing cell are shown in D-111-92-1 and D-111-92-2.

2. Remote Manipulation Cell

This cell provides the necessary shielding and remote manipulators necessary for work with very high levels of radioactivity such as would be present when investigating processing and packaging techniques for fission products. The physical layout of this is illustrated in Figure 2, D-111-91-2, and D-111-91-4.

The remote manipulator is designed to raise and move articles from any position a foot or more from the cell wall. In addition, the manipulator will do simple hand motions such as turning or wrist motions. Special adaptors can be supplied for the variety of jobs this manipulator will be required to do.

The manipulator will be operated from behind a high density glass or shielded window, and is shown in D-111-91-2. Those view angles not covered by the window can be seen by a periscope equipped with a movable mirror. This periscope is mounted alongside the mirror as shown in D-111-91-2.

Access to equipment in this cell is provided through a removable hatch cover at the top of the cell and through the laybrinth corridor from the remote manipulation control area.

Any radioactive material that must be transported from the processing cell to the remote manipulation cell must be handled in a shielded cask. If it is necessary for personnel to enter the remote manipulation cell for maintenance or other work, any radioactive material present in the cell would be placed into shielded casks. The remote manipulator is designed to remove the lid on the shielded cask, place the radioactive material in the cask and replace the lid. This procedure means that a cask must be kept in the remote manipulation cell.

3. Cold Operating and Makeup Area

Part of the functions of this area have already been discussed in connection with the processing cell. The space shown on D-111-91-1 marked chemical storage can be made available for unit operation for the study of radiation initiated chemical reactions, sterilizations, or other purposes. For investigation of processes for separating specific fission products from gross fission products this space is used for solution feed or makeup tanks required in the processes.

The area also serves as an access way to the cells through the cell hatchways. The bridge crane is provided to lift and set aside these hatch covers.

The lead plate shown in D-111-91-1 covers the flange on the irradiated fuel element dissolver. These fuel elements are assumed to be brought into the area in a shielded cask that unloads through a sliding gate in the bottom. The dissolver flange bolts are removed with the lead plate in place, the cask is

placed over the dissolver and is guided into place by tapered guide pins, the lead plate and dissolver flange are slid back exposing the dissolver entrance pipe, the bottom gate on the cask is slowly opened, and the fuel elements drop one by one into the dissolver. The steps outlined are then done in inverse order which leaves the dissolver ready for operation.

Other equipment in this area not mentioned before are the actuating pistons and controls for the remote head pumps used in the process. These are items 405-1, 2, 3, and 4, situated behind the control board.

4. Chemical Laboratory and Sampling Areas

A chemical laboratory is provided for control analysis of the extraction process. However, not all the space or facilities of the laboratory will be required for this purpose. Research on many other phases of radiochemistry, radiation initiated chemical reactions, or other "hot" work can readily be done in the same facilities.

The laboratory is provided with glove boxes, hot hoods, and other equipment necessary to do work on radioactive materials. The layout of the laboratory in relation to the rest of the building is shown in D-111-91-1.

A sample corridor is needed for sampling the hot streams of the extraction process. In this corridor a jet vacuum system transfers a solution from the vessel, whose contents are to be analyzed, into a sample bottle. The small quantity of solution in the sample bottle is diluted by a definite quantity of water and an aliquot of the diluted solution is taken for analysis. The dilution of the initial sample results in a material that is "cold" enough to analyze by normal radiochemical procedures.

These operations are all conducted remotely behind thick concrete shielding until the final sample is withdrawn. The equipment that does these operations has been developed and is in daily use. Costs and knowledge of types of equipment that might be used are based upon past experience in the field.

C. Safety Provisions

Safety provisions as to design and operation have been adhered to based upon current practices and procedures in the Atomic Energy Commission installations. In no case will the allowable tolerance level for personnel working in the area be exceeded and for areas occupied frequently by personnel these levels will not be approached. Suitable radiation monitors have included in the estimated cost such that continuous checking of radiation in given areas can be done.

All liquid wastes that must be discharged from the process will be decontaminated twice by evaporation and then analyzed before discharge. All acids are neutralized in the evaporation step such that no chemical wastes will be discharged. These methods result in discharging waste water which meets tolerance standards.

Radioactive gases that are evolved in the fuel element dissolution step are scrubbed with caustic solution to remove radioactive iodine and bromine.

Any radioactive krypton or xenon is removed in adsorbing material. The remainder of the gas is non-radioactive and is filtered through special filters and discharged from a stack. With these provisions, no radioactivity can be discharged to the atmosphere.

It should be emphasized at this time that this is a proposal and not a final design. Should this project progress into a final design stage, the safety aspects would be thoroughly reviewed to insure that no safety provision had been omitted in the proposal preparation.

IV. OFFICES AND BUILDING UTILITIES

The building proposed includes two offices, lavatories, and general utilities. Since the building location in relation to other campus facilities is uncertain, a steam generator was included in the facilities. This generator will provide low pressure steam for building heating through a pressure reducer, and high pressure steam for process and pilot plant uses. Other utilities provided include an air compressor and water demineralizer.

Provisions have been made in the costs for sewer and water line connections to the building. No costs for roadway construction to the building were made.

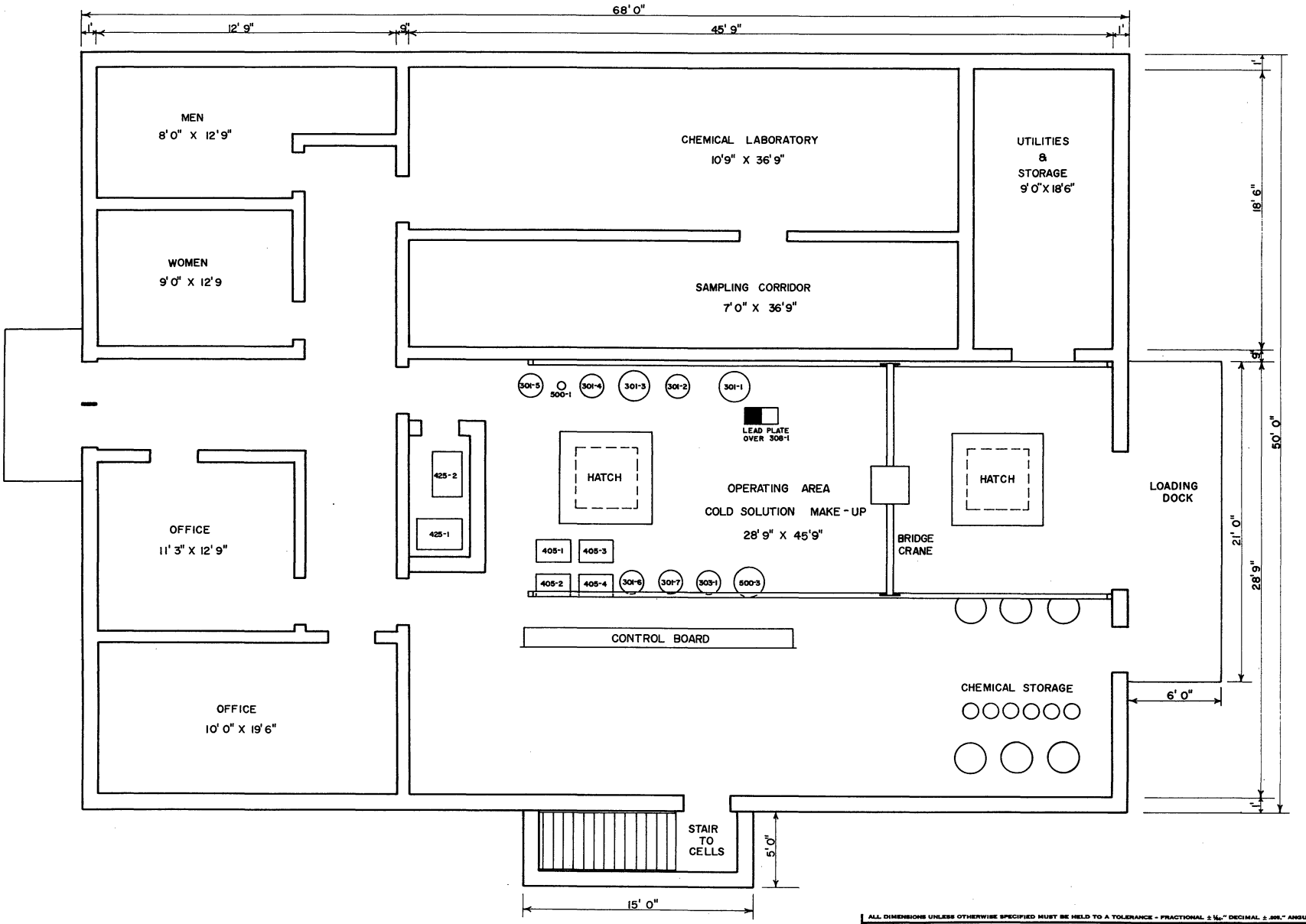
V. COST SUMMARY

A summary of unit costs are given in Table I below. Only the major breakdowns are given. However, the pricing of individual items was gone into in considerable detail. Much of the cost data was based on quotations from equipment manufacturers. Estimates of building costs were arrived at by combinations of contractor quotations and considerable past experience in the pricing of Atomic Energy Commission installations.

TABLE I

COST SUMMARY ON REMOTE MANIPULATIONS, PROCESSING, AND LABORATORY PROPOSAL

Process Equipment and Machinery	$265,000
Buildings and Structures	355,000
Total Estimate	$620,000



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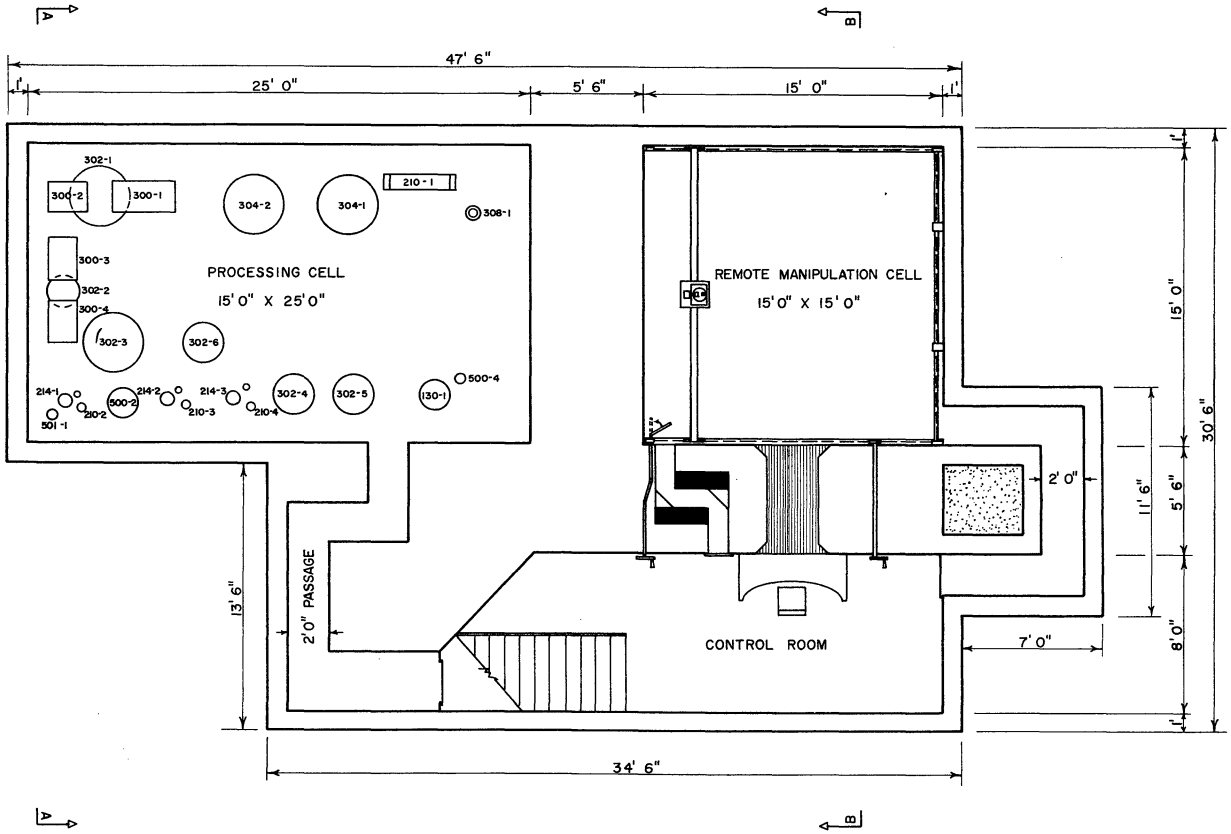
			DRAWN BY DT	SCALE 1" = 4'
			CHECKED BY	DATE 3-1-55
		PROJECT HOT CELL PROPOSAL D-111	TITLE COLD SERVICE & OPERATING AREA —PLAN—	
		CLASSIFICATION	DWG. NO. D-111-91-1	
ISSUE	DATE			



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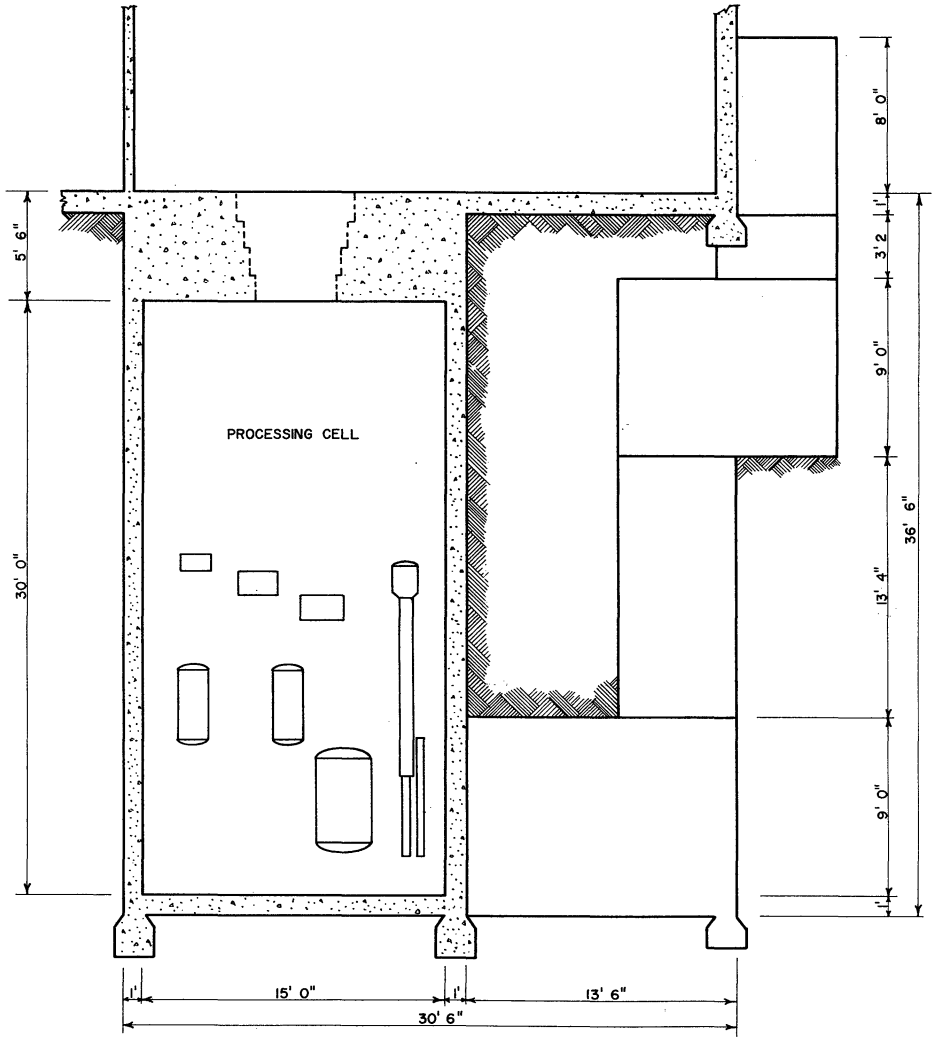
CLASSIFICATION		DWG. NO. D-111-91-2	
ISSUE	DATE		



SECTION A-A

ALL DIMENSIONS UNLESS OTHERWISE SPECIFIED MUST BE HELD TO A "TOLERANCE - FRACTIONAL ± 1/64" DECIMAL ± .005," ANGULAR ± ½°

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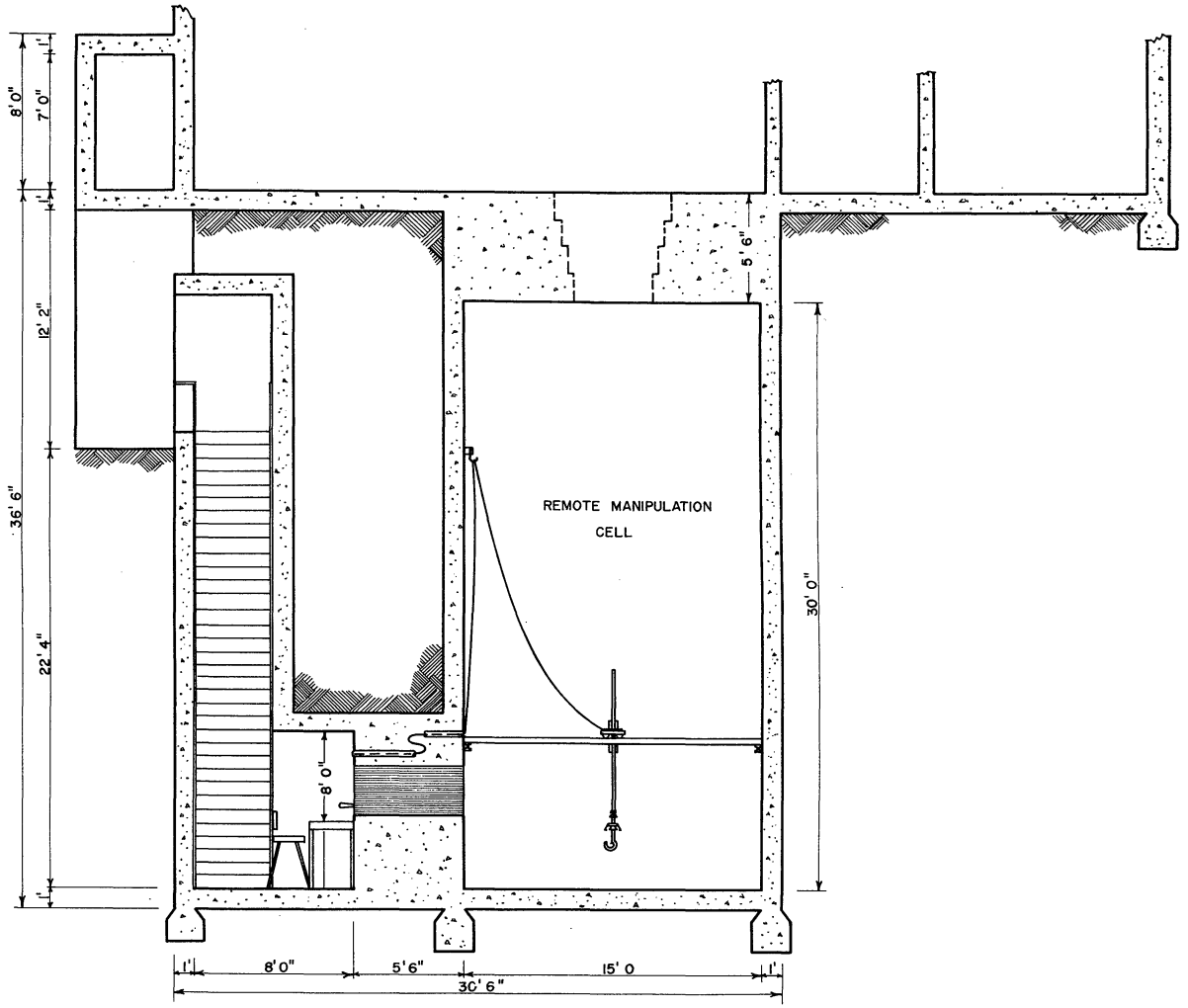
		DRAWN BY D.T	SCALE 1" = 4
		CHECKED BY	DATE 2-28-55
PROJECT HOT CELL PROPOSAL D-111		TITLE PROCESSING CELL - ELEVATION -	
CLASSIFICATION		DWG. NO. D-111-91-3	
ISSUE	DATE		



SECTION B-B

ALL DIMENSIONS UNLESS OTHERWISE SPECIFIED MUST BE HELD TO A TOLERANCE - FRACTIONAL ± 1/64" DECIMAL ± .005" ANGULAR ± ½°

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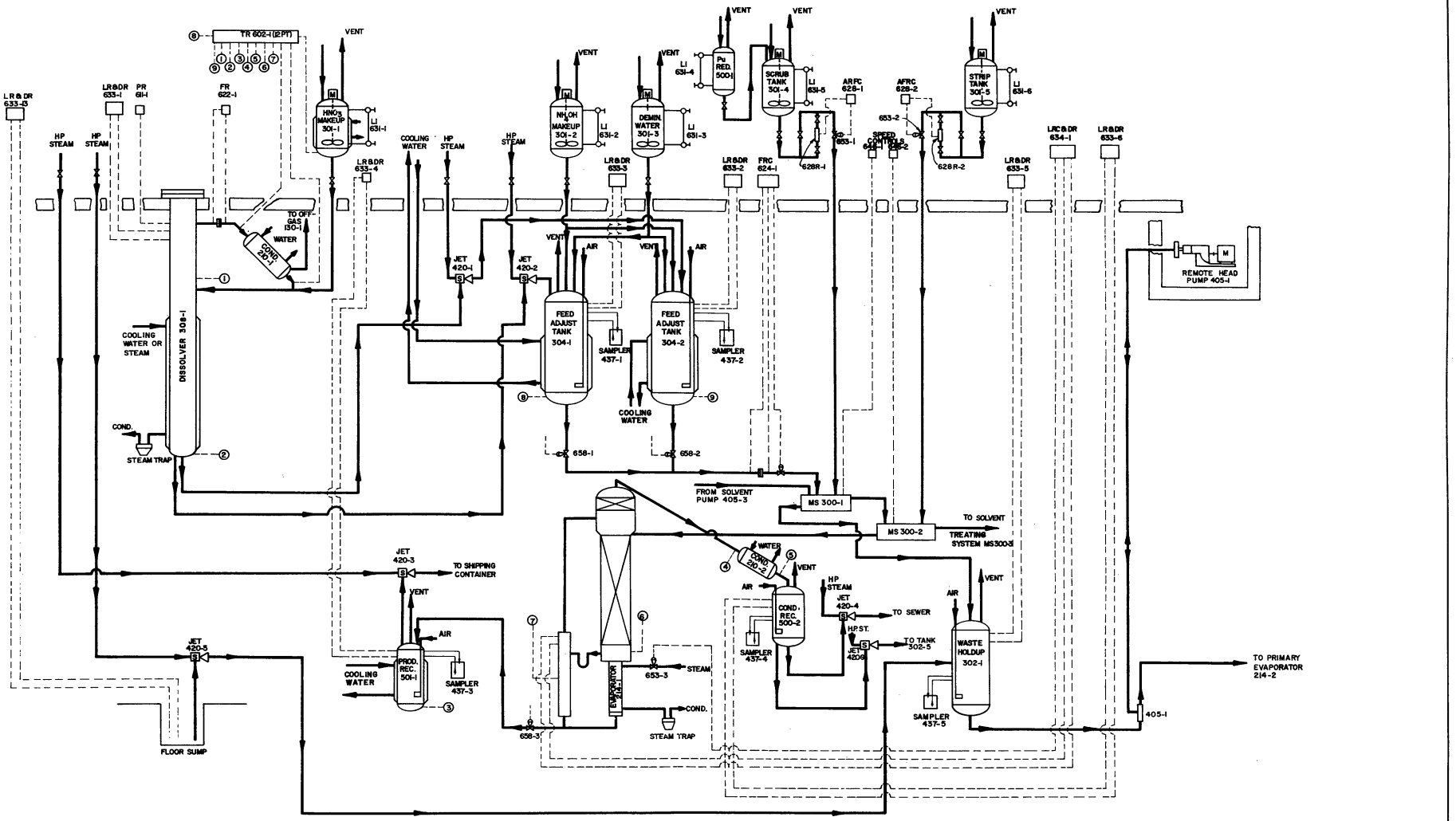
		DRAWN BY DT	SCALE 1" = 4'
		CHECKED BY	DATE 2-28-55
PROJECT HOT CELL PROPOSAL D-111		TITLE CONTROL ROOM & REMOTE MANIPULATION CELL -ELEVATION-	
CLASSIFICATION		DWG. NO. D-111-91-4	
ISSUE	DATE		



ALL DIMENSIONS UNLESS OTHERWISE SPECIFIED MUST BE HELD TO A TOLERANCE - FRACTIONAL 1/64; DECIMAL - .005; ANGULAR - 1°

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UNIVERSITY OF MICHIGAN
ANN ARBOR MICHIGAN

PROJECT D-III

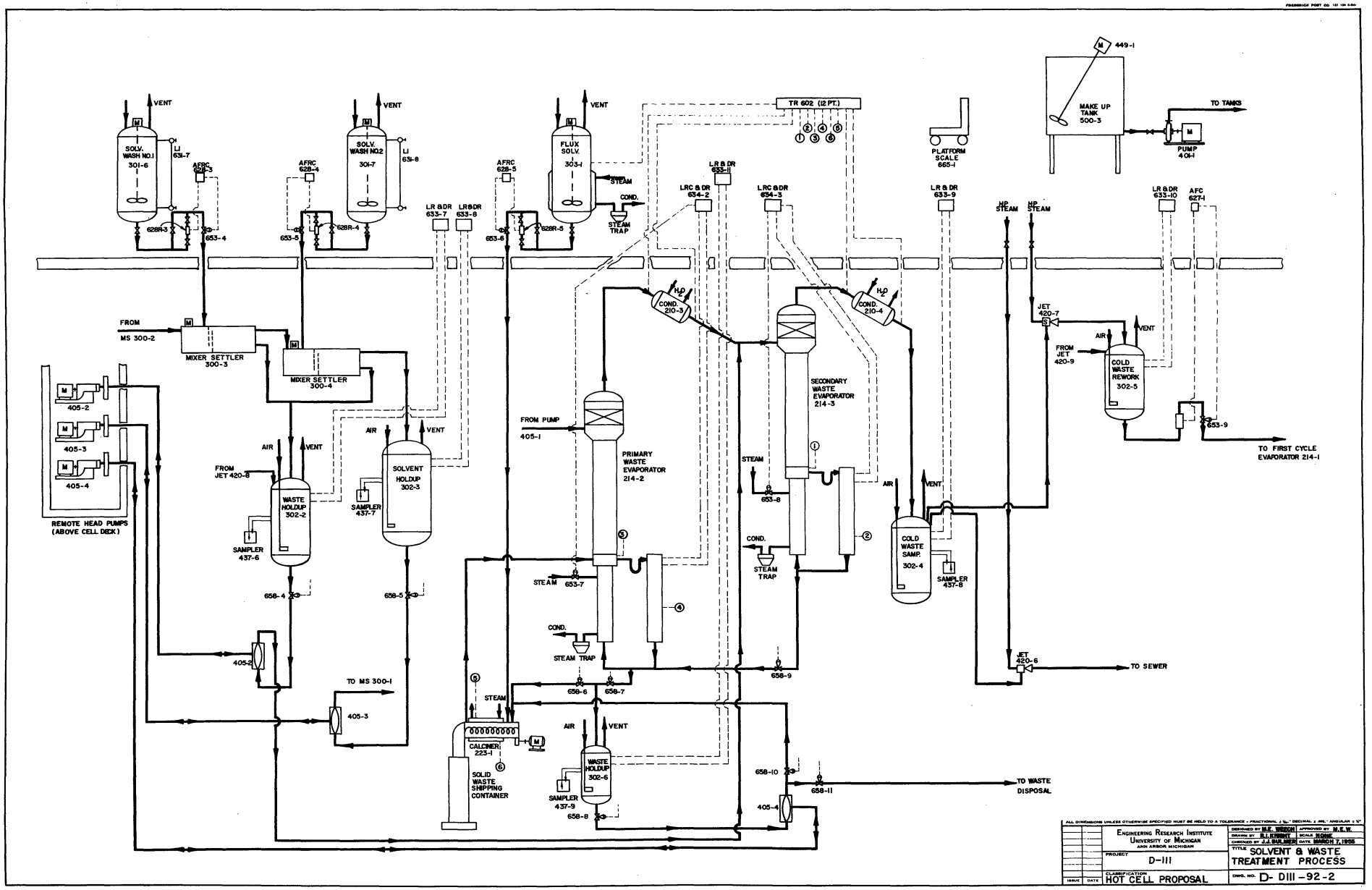
CLASSIFICATION HOT CELL PROPOSAL

DESIGNED BY M.E. WEECH APPROVED BY M.E.W.
DRAWN BY R.J. KNIGHT SCALE NONE
CHECKED BY J.J. GULDEN DATE FEB. 25, 1958

TITLE DISSOLUTION & SOLVENT EXTRACTION

DWG. NO. D-DIII-92-1

ISSUE DATE


SOLV. WASH NO.1 301-6
SOLV. WASH NO.2 301-7
FLUX SOLV. 303-1
VENT
LI 631-7
LI 631-8
AFRC 628-3
AFRC 628-4
AFRC 628-5
628R-3
628R-4
628R-5
653-4
653-5
653-6
LR & DR 633-7
LR & DR 633-8
STEAM
COND.
STEAM TRAP
TR 602 (12 PT.)
PLATFORM SCALE 685-1
MAKE UP TANK 500-3
449-1
TO TANKS
PUMP 401-1
LRC & DR 634-2
LR & DR 635-11
LRC & DR 634-3
LR & DR 633-9
HP STEAM
LR & DR 633-10
AFC 627-1
FROM MS 300-2
MIXER SETTLER 300-3
MIXER SETTLER 300-4
COND. 210-3
COND. 210-4
H.P.
JET 420-7
AIR
VENT
FROM JET 420-9
COLD WASTE REWORK 302-5
653-9
TO FIRST CYCLE EVAPORATOR 214-1
405-2
405-3
405-4
REMOTE HEAD PUMPS (ABOVE CELL DECK)
FROM JET 420-8
WASTE HOLDUP 302-2
SAMPLER 437-6
SOLVENT HOLDUP 302-3
SAMPLER 437-7
FROM PUMP 405-1
PRIMARY WASTE EVAPORATOR 214-2
SECONDARY WASTE EVAPORATOR 214-3
STEAM
653-8
COND.
STEAM TRAP
COLD WASTE SAMP. 302-4
SAMPLER 437-8
658-4
658-5
653-7
658-9
658-6
658-7
TO MS 300-1
405-1
405-3
CALCINER 223-1
SOLID WASTE SHIPPING CONTAINER
WASTE HOLDUP 302-6
SAMPLER 437-9
658-8
658-10
658-11
TO WASTE DISPOSAL
JET 420-6
TO SEWER
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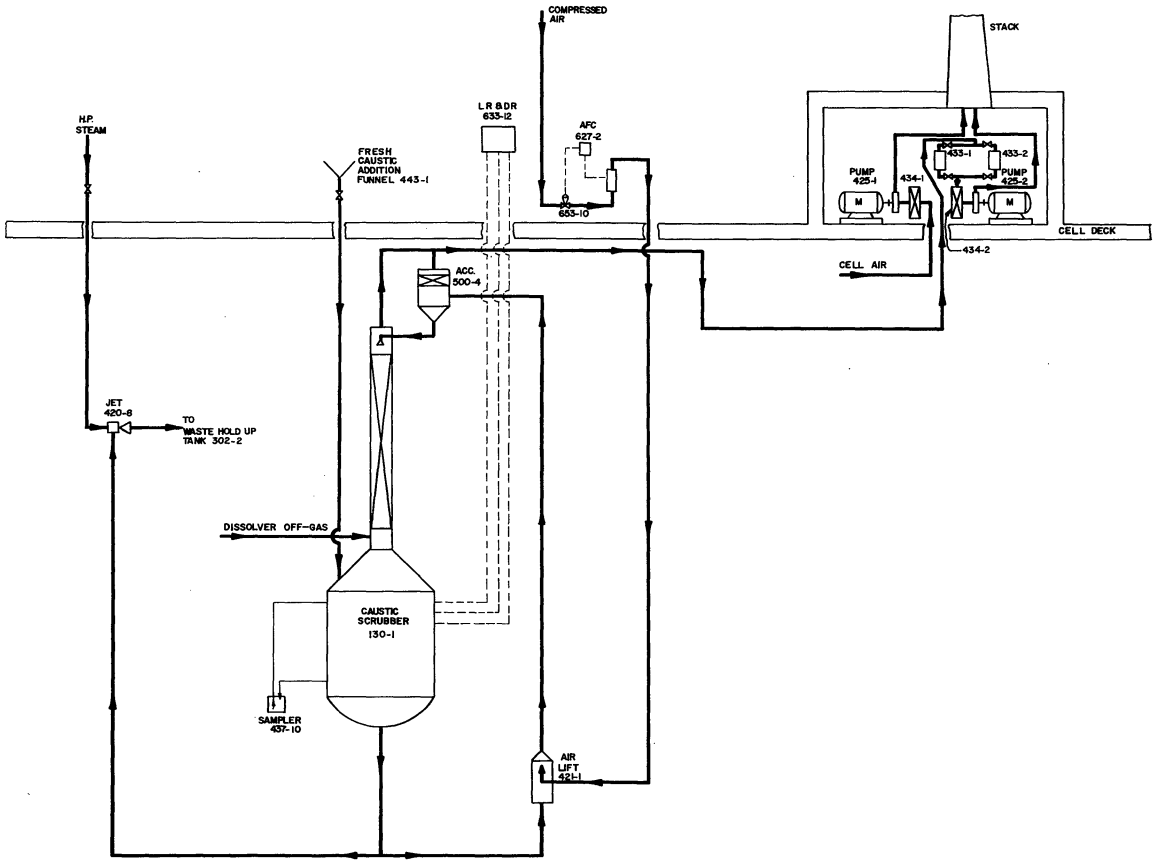
ANN ARBOR MICHIGAN
PROJECT D-111
CLASSIFICATION HOT CELL PROPOSAL
DESIGNED BY M.E. WISCOM
APPROVED BY M.E.W.
DRAWN BY R.J. KENNEY
SCALE NONE
CHECKED BY J.J. BURNETT
DATE MARCH 7, 1955
TITLE SOLVENT & WASTE TREATMENT PROCESS
DWG. NO. D- DIII-92-2



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ENGINEERING RESEARCH INSTITUTE UNIVERSITY OF MICHIGAN ANN ARBOR MICHIGAN		DESIGNED BY M.E. WEECH	APPROVED BY M.E.W.
		DRAWN BY R.T. KNIGHT	SCALE NONE
		CHECKED BY J.J. BULMER	DATE MARCH 10, 1958
PROJECT D III		TITLE OFF-GAS TREATMENT	
CLASSIFICATION HOT CELL PROPOSAL		DWG. NO. D-DIII-92-3	
ISSUE	DATE		